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BRITISH NUCLEAR WEAPON STOCKPILES, 1953–78

JOHN R WALKER

As part of a *RUSI Journal* double feature on the history of British nuclear stockpiles, arms control historian John R Walker presents the latest research on the size and evolution of the British stockpile of nuclear weapons from when they were first made available to the Royal Air Force in 1953 to the peak of production in 1978.

William Hague told the House of Commons on 26 May 2010 that he was ‘pleased to announce today that, for the first time, the Government will make public the maximum number of nuclear warheads that the United Kingdom will hold in its stockpile – in future, our overall stockpile will not exceed 225 nuclear warheads. This is a significant step forward on previous policy, which was to publish only the number of warheads classed as “operationally available”, the maximum number of which will remain at 160. We believe that the time is now right to be more open about the nuclear weapons that we hold.’¹ So, for the first time in almost sixty years as a nuclear weapons state, the UK has released a ministerial statement on its total nuclear weapons stockpile. This is a radical departure from previous practice whereby total stockpile numbers were a closely held secret. It is perhaps now timely to look also at historical holdings of UK nuclear weapons to see what sort of picture can be painted, drawing on official papers at The National Archives at Kew.²

There are many files available at Kew containing information on the plans and requirements for, and historical holdings of, UK nuclear weapons stockpiles from the early days of the programme right up until the end of the 1970s. Information is scattered across a diverse range of records from the main government departments (the Admiralty, Air Ministry, Cabinet Office, Ministry of Aviation, Ministry of Defence and Ministry of

Supply) and the various branches within them involved with nuclear weapons issues. Piecing together the jigsaw is a demanding task as there is no single piece of paper that provides a coherent, authoritative overview; there is of course also the nagging doubt that key pieces of the jigsaw possibly are still missing. Definitional issues are also a problem: what is a nuclear weapon? There were weapons deployed to the RAF and Royal Navy but there were also surveillance rounds and even spare components (nuclear and non-nuclear), such as fissile cores and aircraft bomb tail assemblies. Constantly changing plans are other significant complexities to disentangle. Establishing the facts from the available historical record is thus inordinately difficult.

The following table is the first attempt to compile as accurate a picture as possible of the different types of British nuclear weapons and their numbers from November 1953, when the first weapon was made available to the RAF at Wittering, to 1978, when the UK stockpile appears to have been at, or close to, its highest level in terms of total numbers produced. This table is also an initial contribution to the promotion of greater transparency on historical aspects of nuclear weapons stockpiles based on official records – a factor that may assume greater significance as further progress is made towards the goal of nuclear disarmament. It also highlights that there are inevitable gaps in the historical record and the

enormous scale of the task in compiling detailed, comprehensive and accurate accounts spanning a period of almost thirty years.

It has proved slightly easier to provide accurate figures for deliverable nuclear weapons in the period of 1958–64, as Richard Moore has shown in his recent book *Nuclear Illusion, Nuclear Reality*, published by Palgrave in 2010. Appendix 1 of this book provides a breakdown of the numbers of each weapon type and the total stockpile numbers for each year.³ Britain’s stockpile increased from sixty-three weapons in 1958 to 264 in 1964.⁴ As this present study shows, the UK stockpile expanded to a maximum size of up to 462 warheads by the late 1970s, with the major overall expansion in total numbers coming at the very end of the 1960s and early 1970s. The early weapons were expected to have a short shelf life as the consequences of ageing were unknown at that time; it was only the WE177 weapons and Polaris warhead that had much longer life spans. If the 462 figure is accurate, then it would seem that in simple numerical terms the UK nuclear weapons stockpile today has decreased by over 50 per cent since 1978.

Reading Notes

In addition to the points mentioned above, there are several important caveats to bear in mind when reading the table.

First, the information included has been taken and pieced together from declassified papers in The National

Archives or other official histories or statements: no closed records were used. There are still gaps and uncertainties, so this represents the best estimate from these sources. Furthermore, some of the information is based on inference from the available sources.

Second, there is a distinction in the UK system between weapons deployed to the RAF and Royal Navy and those held as spares to cover for maintenance cycles.

Third, the use of papers covering many years and from several government departments often reveals apparent contradictions. These can be partly explained by changing plans and requirements, often caused by budgetary retrenchment.

Fourth, the table's detailed footnotes reveal the various sources of information, some of which are historical accounts written some years later, at the time the table was compiled; in other words, these accounts look back to previous reports and understandings. Other sources were future-looking statements on intentions and plans, which were apt to change as circumstances changed. As a result,

it is not clear whether all of the plans referenced were fully implemented.

Finally, further research might be able to reveal a more detailed breakdown of the numbers and types of weapons held in particular years across the whole period. This information is currently available for only parts of the period under review and it is possible that still retained, or yet to be released, papers may have the full answers. There is, however, a timetable of the planned figures for WE177A and C production from the later 1960s to the mid-1970s, which envisaged roughly two weapons per month being completed and made available to the RAF. During the initial part of this period the second generation bomb, Red Beard, and the first thermonuclear warhead, Red Snow, were being withdrawn from service and broken down. Recovered fissile material was re-used in the WE177s, and probably in the Polaris warheads too, but there do not appear to be any definitive sources from the archives that demonstrate the actual withdrawal and dismantlement timetable for each year.

Clearly, more work is required to build a detailed review of UK nuclear weapons holdings for each year and to clarify some of the current uncertainties and possible inaccuracies. Investigation into the numbers of Chevaline warheads is also needed, as these are just beginning to become available at Kew.⁵ It is known, for instance, that the first outload of Polaris missiles was limited to twelve missiles with two warheads, but as of yet there are no details regarding the total number of warheads built and how many were planned in total. ■

Dr John R Walker works in the Arms Control and Disarmament Research Unit of the Foreign and Commonwealth Office. His book, British Nuclear Weapons and the Test Ban 1954–1973 was published by Ashgate in 2010. A follow-up book, Britain and Disarmament: The UK Nuclear, Biological and Chemical Weapons Arms Control and Programmes 1956–1975, will also be published by Ashgate in December 2011.

NOTES

1 *Hansard*, HC Debates, Oral Answers, 6 May 2010, Col. 181.

2 The bulk of the research for this paper was originally undertaken as part of a project at the Mountbatten Centre, Southampton University, funded by the Arts and Humanities Research Council (AHRC), on the history of the UK nuclear weapons programme, 1954–76. See <<http://www.mcis.soton.ac.uk/programmes/bnhistory.php>>. The views

expressed here are the author's own and not necessarily those of the Foreign and Commonwealth Office. The author is also most grateful for advice on the table from Richard Moore and Brian Burnell.

3 Richard Moore, *Nuclear Illusion, Nuclear Reality: Britain, the United States and Nuclear Weapons, 1958–64* (Basingstoke: Palgrave Macmillan, 2010).

4 *Ibid.*, p. 256.

5 See The National Archives DEFE 23/222, 'UK strategic nuclear deterrent: options, Chevaline Project and Production Progress in the DCDP (IV) Area up to 15 October 1980'.

Table 1: Probable British Nuclear Weapons Stockpiles, 1953–78.

| Weapon/Warhead | In Service | Ordered | Maximum Number Deployed | Spares | Surveillance | Yield | Probable Total Produced | In Service, 1978 |
|--|-----------------------|--|------------------------------------|------------------------------------|---------------------|--|-------------------------|--|
| Blue Danube Mk I, II and III | 1953–62 ¹ | 100 ² | 57/58 ³ | 0 | 0 ⁴ | 10/16 kt ⁵ | 57/58 | 0 |
| Red Beard Mk I, II ⁶ and III (RAF and RN) | 1960–72 ⁷ | 110 ⁸ /127/ 142 ⁹ | 110/127/142 ¹⁰ | 17 ¹¹ | 12 ¹² /6 | 15 kt ¹³ | 110 | 0 |
| Violet Club (Green Grass) ¹⁴ | 1958–59 ¹⁵ | 13 ¹⁶ | 5 ¹⁷ | 0 | 0 | 500/400 kt ¹⁸ | 5 | 0 |
| Yellow Sun Mk I (Green Grass) | 1959–62 ¹⁹ | 37 ²⁰ | 22 ²¹ /37 | - | 12 ²² | 400 kt ²³ | 37 ²⁴ | 0 |
| Red Snow warhead ²⁵ | 1961–72 ²⁶ | 120/134 ²⁷ | 120/134 ²⁸ | - | - | 1 Mt ²⁹ | 134 | 0 |
| (a) Yellow Sun Mk II | 1961–67 ³⁰ | 86 ³¹ /96 ³² | 86 ³⁶ | - | - | 1 Mt ²³ | 86/96 | 0 |
| (b) Blue Steel ³³ | 1962–69 ³⁴ | 57 ³⁵ | 40 ³⁶ /48 ³⁷ | 1 | 1 ³⁸ | 1 Mt | 40 | 0 |
| WE177A (RN) | 1969–91 ³⁹ | 60/62/63 ⁴⁰ | 35 ⁴¹ | 8 ²⁹ | 3 ⁴² | 0.5 kt ⁴³ 10 kt ⁴⁴ | 43 | 43 |
| WE177A (RAF) | 1969–98 | 44 ⁴⁵ | 44 | 10 ⁴⁶ /82 ⁴⁹ | 4 ³⁶ | 10 kt | 44/64 ⁴⁷ | 50 ⁴⁸ |
| WE177B | 1966–95 | 53 ⁴⁹ | 48 | 5 | 6 ⁵⁰ | 420/450/500 kt ⁵¹ | 53 | 53 |
| WE 177C | 1972–95 | 125 ⁵² | 115 ⁵³ | 10 ³³ | 4 ³⁰ | 190/200 kt ⁵³ | 125 ⁵⁴ | 125 ⁵⁵ |
| Polaris ET 317 | 1968–82 ⁵⁶ | c.200 ⁵⁷ /251 ⁵⁸ | 192 ⁵⁹ | 47 ⁶⁰ | 2 ⁶¹ | 200 kt | 251 | 191 ⁶² |
| TOTAL | - | - | - | - | - | - | - | c.400 ⁶³ /462 ⁶⁴ |

Note: A dash ('-') represents unknown or unquantifiable data. Acronyms used are as follows: Mark (Mk), Royal Air Force (RAF), Royal Navy (RN), kiloton (kt), megaton (Mt), The National Archives (TNA), Directorate of Atomic Weapons Development (DAWP), Atomic Weapons Research Establishment (AWRE), Directorate of Naval Planning (DN Plans), Anti-Submarine Warfare (ASW), United Kingdom Atomic Energy Authority (UKAEA), Surface-to-Surface Ballistic Missile (SSBN) and Royal Naval Armaments Depot (RNAD).

NOTES TO TABLE 1

- 1 The National Archives (TNA) SUPP 5/1394, 'Royal Ordnance Factory Burghfield, Production and Development Report for Year Ended 31 March 1962' noted that 'breakdown of these weapons continued until August (1961) when the work was transferred to R.O.F., Pembrey'. This site closed at the end of 1964.
- 2 TNA AVIA 65/1792, 'History of Atomic Weapon Production', DAWP, 1963. One hundred was the requirement as it stood in March 1955.
- 3 There were apparently cores for fifty-eight weapons. Storage facilities for forty-eight weapons were built at both RAFs Barnham and Faldingworth and ten weapons at four RAF stations. See TNA AVIA 65/1160 and Wayne D Cocroft, and Roger J C Thomas in P S Barnwell (ed.), *Cold War: Building for Nuclear Confrontation 1946–1989* (Swindon: English Heritage, 2004), p. 30. All of the Mk II weapons and new assemblies were converted by 31 March 1958, following a decision in the autumn of 1957; see TNA SUPP 5/1408, 'Royal Ordnance Factory Burghfield Report for the Year Ended 31 March 1958'.
- 4 The surveillance round concept was not adopted in the UK stockpile until later generation weapons.
- 5 TNA AVIA 65/1160, 'Bomb Aircraft HE 10,000 lb MC, DAWDP, Ministry of Supply to miscellaneous addressees', 22 February 1957; TNA AIR 8/2469, 'William Cook, AWRE to E S Jackson, DGAW, Ministry of Supply', 27 June 1956. The initial order for nineteen weapons called for yields of 10 kilotons; see TNA DEFE 19/45, 'Confidential Annex to COS (53) 9th Meeting, Atomic Weapons', 20 January 1953.
- 6 TNA AIR 6/151, Annex to AC (62)12, 'Nuclear Weapons', 28 March 1962 noted that the Mk II entered service in December 1961.
- 7 TNA SUPP 5/1401, 'Royal Ordnance Factory Burghfield Report for Year Ended 31 March 1972'. All Red Beards and Red Snow warheads were withdrawn and broken down during this year.
- 8 TNA AIR 2/13774, 'T J Goggin to Ops. (B) 3 and Wpn Eng2, Red Beard Requisitions', 28 March 1960. This figure may in fact be the final number as a file from later in the 1960s refers to the WE177A being a 'replacement for the hundred or so Red Beard bombs deployed now in Cyprus, Singapore and afloat to fulfil our commitments to CENTO and SEATO'. See TNA DEFE 19/103, 'The Navy's Requirement for WE177A', 19 May 1966.
- 9 TNA AVIA 65/1792, 'History of Atomic Weapon Production', DAWP 1963. One hundred and twenty-two were delivered to the RAF by December 1962, along with thirty-five for the Admiralty. However, another source makes clear that there were ninety-one Mk I and thirty-six Mk II versions ordered – in the latter case that was at least a proposal. TNA AIR 2/13774, 'R J Penney, Air Ministry to C W Fogarty, Treasury', 10 February 1960.
- 10 TNA AVIA 65/1792, 'History of Atomic Weapon Production', DAWP, 1963. Other references suggest that there were 110 RAF weapons, but by the end of the 1960s there appear to have been ninety-four still in service; see TNA AIR 2/18210, 'Nuclear Weapons Policy, 1969–70'.
- 11 TNA AIR 6/117, 'Air Council Memoranda', 1–104, 1959.
- 12 These were drill weapons for training RAF/RN ground crews; the round had the same shape, dimensions and centre of gravity. Surveillance weapons were identical to service weapons except that the fissile components were replaced with inert materials, such as brass or depleted uranium. See TNA AVIA 65/1792.
- 13 TNA AVIA 65/1155, 'Nominal yield of service designs', C W Shaw, ADAW (D) 1 to DD OR2, 28 November 1956.
- 14 Green Grass was a large fission-only weapon using large quantities of highly enriched uranium. It was based on an AWRE design known as Knobkerry. See Richard Moore, *UK Nuclear History Working Paper Number. The Real Meaning of the Words: a Pedantic Glossary of British Nuclear Weapons*, Mountbatten Centre for International Studies, <http://www.mcis.soton.ac.uk/Site_Files/pdf/nuclear_history/Working_Paper_No_1.pdf>, accessed 15 September 2011.
- 15 The Violet Clubs were converted into Yellow Sun Mk IIs between April and August 1959: TNA AIR 6/117, 'Air Council Memoranda 1959, Progress Report on Nuclear Weapons Appendix AC (59) 7', 13 January 1959.
- 16 The number of interim weapons was originally estimated at sixteen, but this was reduced to fifteen so that the Admiralty could have some highly enriched uranium and a further reduction was made to thirteen due to the additional megaton trials in the Pacific; see TNA AIR 2/13718, 'Interim Megaton Weapons', DGAW to DCAS, 19 September 1957.
- 17 TNA AVIA 65/1218, 'C H B Bullock (Group Captain) DAWP to SSWP/AWRE, Violet Club Production', 18 November 1958. There was one drill round produced, that is, an inert ballistic shape to enable ground handling and flight trials. TNA AIR 2/13705, 'E J Smith, DDE 3 to DDOR 2, UK Megaton Weapon Programme', 30 October 1958.
- 18 AWRE recalculated the yield of Green Grass at about 400 kilotons with a possible variation of +/- 15 per cent between rounds. (Megaton range defined as 500 kt and above). TNA AIR 2/13705, 'Green Grass Warhead', A Smith, DDOR 2 to DD Ops (B).
- 19 Last-minute delays in Yellow Sun clearance resulted in the RAF taking delivery of a total of five Violet Clubs; delivery of Yellow Sun Mk I was due in January 1959. The conversion of Violet Clubs to Yellow Sun was planned to start in April for completion by August. TNA AIR 6/117, 'Progress Report on Nuclear Weapons', Appendix AC (59) 7, 13 January 1959.
- 20 TNA AVIA 65/1792, 'History of Atomic Weapon Production', DAWP, 1963.

- 21 Production of the Green Grass warhead was due to cease after twenty-two had been produced in March 1960 with all further Yellow Sun deliveries being the Mk II version, the first of which was planned for mid-1960; see TNA AIR 2/13705, 'Yellow Sun policy, 1957–1966'.
- 22 TNA AIR 2/13705, 'Yellow Sun – Application Policy', G M Brisbane, A/DDOR 2 to DD Ops (B), OR 1136, 2 August 1957.
- 23 AWRE recalculated yield of the Green Grass warhead at about 400 kt with a possible variation of +/- 15 per cent between rounds. (Megaton range defined as 500 kt and above). See TNA AIR 2/13705, 'A Smith DDOR 2 to DD Ops (B), Green Grass Warhead'.
- 24 TNA AVIA 65/1992, 'History of Atomic Weapon Production', DAWP, 1963.
- 25 Red Snow was the megaton warhead used in both Yellow Sun Mark II and Blue Steel.
- 26 TNA SUPP 5/1401, 'Royal Ordnance Factory, Burghfield Report for Year Ended 31 March 1972'. All Red Beards and Red Snow warheads were withdrawn and broken down during this year.
- 27 Production order for Red Snow was cut down from 144 to 134, leading to a surplus of ten carcasses. See TNA AIR 2/13705, 'P R M Groom to Ops (B)', 3 July 1962. There also appears to be a discrepancy in production orders between warheads and carcasses. The 120 figure comes from TNA AVIA 65/1792.
- 28 This is an estimate based on the fact that the front-line V-force was under 100 aircraft and that the force was shared between Yellow Sun Mk II and Blue Steel. Twenty-one Red Snow warheads were converted to use in Blue Steel, thus rendering twenty-one Yellow Sun carcasses surplus to requirements. See TNA AIR 2/13705, 'E D Crew A/D of Ops (B & R) to Head of S.9', 27 July 1964. See also TNA AIR 2/13705, 'D A Green, DD Ops (B) (RAF) to DDE 3 (RAF), Yellow Sun Mk2 – Disposal of Carcasses', August 1964'.
- 29 TNA AIR 2/13705, 'Air Staff Requirement No. O.R.1136 (Issue 3) Yellow Sun Mark 2'.
- 30 TNA AIR 2/13705, 'W J Stacey DD Ops (B) RAF to DD OR 10 (RAF)', 18 May 1966 – originally meant to be returned by the end of July, but extended to the end of December 1967. The WE177B served as replacement.
- 31 TNA AIR 2/13705, P R M Groom to Ops (B) 3, 'Discrepancy in Production Orders between Warheads and Carcasses, 3 July 1962'.
- 32 TNA AVIA 65/1992, 'History of Atomic Weapon Production', DAWP, 1963. Figures as of December 1962.
- 33 TNA AIR 2/13705, E D Crew A/D of Ops (B & R) to Head of S.9, 27 July 1964 notes that, 'Bomber Command transferring Red Snow warheads from Yellow Sun 2 to Blue Steel to match the front-line force of Blue Steel aircraft. By the end of 1964 the transfer should be completed and about 21 Yellow Sun carcasses will become surplus to operational requirements'.
- 34 Humphrey Wynn, *RAF Nuclear Deterrent Forces* (London: The Stationery Office, 1994), p. 631.
- 35 The figure here represents missiles, not warheads. TNA AIR 19/1014, 'Draft Memorandum by the Minister of Aviation, Blue Steel, Defence Committee D. (62) 1st meeting', 12 January 1962.
- 36 TNA AIR 6/152, Annex to AC (63) 9, 'Future Nuclear Warhead Programme for the V-Force, 1963' notes that the plan was for eighty-eight front-line aircraft with forty carrying Blue Steel; the remaining forty-eight would carry the WE177B.
- 37 TNA AIR 2/17065, 'BS Post-Acceptance Launch Programme Annex to Memo AF/T661/64/DDOR9 (RAF)' dated 8 January 1965; Wynn, *op. cit.*, p. 217 states that only five V-bomber squadrons were fitted with Blue Steel, that is, forty as the unit establishment for a squadron was eight aircraft. See also TNA AIR 6/152, 'Future Nuclear Warhead Programme for the V-Force', Annex C to AC (63) 9, 1963.
- 38 TNA AIR 20/1080, 'Blue Steel: Nuclear Warheads 1959–1963', D A J West to AUS (A), 19 December 1962.
- 39 TNA PREM 13/3126, 'Deployment and Movement of Nuclear Weapons 1964–1970', Secretary of State for Defence to Prime Minister, 16 June 1969. The tactical nuclear weapon Red Beard was now becoming obsolescent and unstable for low-level, tactical work.
- 40 TNA AIR 2/17372, R Haynes (AUS (AS) to ACAS (Pol), 'Draft submission from Chief of the Air Staff to Secretary of State', 26 November 1968. The order for the WE177A for the Royal Navy was placed in 1966 and completed in December 1968. The order for the RAF weapons was delayed pending decisions on the strike force size. TNA AIR 2/18209, 'Requirements for WE177 A Background Note Annex B to ACAS (Pol)/A890', 7 January 1969. Some of the naval orders were converted to RAF use. The original plan was for twenty in the strike role, with forty-three for ASW. See TNA AIR 20/11515, 'Requirements for WE177A Background Note to LD', Mavor ACAS (Pol), to PS to CAS, 23 January 1968.
- 41 TNA DEFE 69/464, 'Defence Review – Nuclear Matters', Annex A to DN Plans SF, 17 April 1974 in Assistant Director of Naval Plans (Polaris) to CFS Co-ord *et al.* The Annex showed DN Plans' understanding of present and planned future policy relating to the 600 lb bomb.
- 42 A table in TNA DEFE 72/152, 'WE177 nuclear bomb; life storage programme, including surveillance 1973–74' implies that there were seven (three for the RN and four for the RAF) in the programme for 1972–84. 'T P O'Callaghan, Hunting Engineering Limited, Post Development Services to MOD, WE177 Surveillance and Life Evaluation Programme', 25 October 1973. See also 'C J Richards, WD2/SSDW AWRE to Mr T P O'Callaghan, PDS Hunting Engineering Ltd, WE177 Annual Report – Period 1 July 1974 to 30 June 1975', 18 August 1975 which clearly refers to seven rounds (three RN and four RAF) and their then status.

- 43 TNA DEFE 19/103, 'Weapons Development Committee: Nuclear Sub-Committee 1964—1966, The WE177 Nuclear Weapons System, Chief Scientific Adviser'. It seems that the plan was for most of the navy's weapons to be for the anti-submarine role; see TNA DEFE 103, 'The Navy's Requirement for WE177A', 19 May 1966. The nuclear depth bomb variant (the 0.5 kiloton yield WE177A) was earmarked for delivery by helicopters; see TNA DEFE 13/545, 'Naval Airborne Nuclear Weapons', Chief of the Defence Staff to Secretary of State, 28 May 1970.
- 44 TNA DEFE 69/464, 'Annex A to DN Plans SF', 17 April 1974 in 'Assistant Director of Naval Plans (Polaris) to CFS Co-ord et al. *Defence Review – Nuclear Matters*' notes that the navy principally used its WE177As as anti-submarine bombs and embarked fourteen Buccaneers on HMS *Ark Royal* (presumably in a strike role). This would imply that of the thirty-five WE177As deployed at sea, twenty-one were in the ASW role. Eighteen weapons were embarked on HMS *Ark Royal*, seven each on HMS *Tiger* and *Blake* and nine on HMS *Hermes*.
- 45 TNA AIR 2/18209, 'Nuclear Weapons for the RAF', Chief of the Air Staff to Secretary of State, 24 January 1969; TNA AIR 20/12080, 'Nuclear Weapons policy 1967—1969', J G Matthews, DD Ops (S) RAF to DD Mech Eng 3 (RAF), 'Future deployment of nuclear weapons – Availability of Existing SSAs for conversion to other purposes'; 'British Nuclear Weapons in Germany', D C Humphreys, Head of DS 9, 27 September 1968; J D Thirlwell, A/D of Ops (B&R) (RAF) to D Air Plans, 'WE177A – Weapon Requirement', 21 November 1967; TNA DEFE 19/125, 'Production of weapons and fissile material 1964 Jun 01 – 1969 March 31'. See also papers in TNA AIR 2/18209 and TNA AIR 2/18210 and TNA AIR 20/12080, AIR 20/12198 and AIR 20/12199 that state that the RAF ordered fifty-six plus eight spares. There is also the question of conversion of WE177As to WE177Cs. See TNA DEFE 19/191, 'Minutes of Warhead Safety Co-ordinating Committee', 20 January 1975, which noted that 'a certain number of ET.317 (i.e. Polaris) warheads broken down for re-use of the secondaries in KH 793 (Chevaline) would be subjected to detailed examination; the same would apply to any WE177A rounds converted to WE177C'.
- 46 TNA AIR 2/18209, D C Humphreys, Head DS 9, to ACAS (Pol), 16 January, 'WE177B Supplementary Qs on WE177 submission'. Ten spares were needed, based on experience and UKAEA advice, to ensure the required number of operational weapons were always available and in fully serviceable condition; a stockpile of spares permitted safety and reliability testing over the period of the weapon's service life.
- 47 It is not clear whether the RAF's full order was fulfilled or whether it was made up from the twenty transferred from the RN order. If the Macklen figure cited in note 63 below is the baseline, then we should assume that the order was made up of up of twenty transferred from the navy. This leads to a figure closer to 400.
- 48 Perhaps fourteen weapons from the WE177A order for the RAF were converted into WE177C.
- 49 Production of the WE177B began in November 1965 in order to meet an in-service date of June 1966, which slipped to September. See Wynn, *op. cit.*, pp. 462 and 87.
- 50 TNA DEFE 19/103, 'Weapons Development Nuclear Sub-Committee, WE177 Surveillance Programme, Brief for Meeting on Wednesday 28 April 1965'.
- 51 TNA AIR 2/18209, 'Nuclear Weapons for the RAF', Chief of the Air Staff to Secretary of State, 24 January 1969. Other sources in TNA DEFE files state 450 kilotons. The 420 kiloton yield figure appears in TNA CAB 134/4431, 'Secretary of State for Defence to Cabinet Committee on Nuclear Policy, Tactical Nuclear Weapons for the RAF', Annex, 11 February 1972.
- 52 TNA CAB 134/4431, 'Tactical Nuclear Weapons for the RAF, NP (72)1', 11 February 1972.
- 53 TNA AIR 2/18210, 'RAF Germany Buccaneer Strike Capability', J G Matthews, DD Ops (S) (RAF) to DD Air Plans, 15 October 1970. See also TNA CAB 134/4431, 'Tactical Nuclear Weapons for the RAF NP (72)1', 11 February 1972. This proposed that the plan was to have two weapons per aircraft for the Buccaneers in Germany and the UK and one per Jaguar in Germany only. The total requirement on this basis was for 175 weapons, including fifteen for servicing purposes of which 110 would be for the Buccaneers and sixty-five for the Jaguars. Completion of the order was planned to be in 1976–77.
- 54 TNA DEFE 69/464, 'Chiefs of Staff Committee Defence Policy Staff, DP 13/74 (Final)', 7 June 1974. The 1974 Defence Review (Nuclear Aspects) Report by the Directors of Defence Policy notes that one of the options in the defence nuclear review was to abandon all the UK's tactical nuclear weapons – this was option four. However, the chiefs of staff considered 'that the RN/RAF tactical weapon programme should continue to complete the present programme and we reject saving Option Four'. This report also noted that the programme to produce an increase in the number of weapons was to be completed in 1976–77. However, with a production rate at two weapons per month, there would only be 101 by the end of 1977 unless the production rates were slightly increased to give 125.
- 55 Some WE177As orders were converted into WE177Cs. In correspondence with the author, Richard Moore believes that the figure could have been fourteen; see TNA AIR 6/194, Annex D to AF/s200/10, 15 October 1976, 'Air Force Board Standing Committee RAF Policy and Programmes (Note by DUS (Air))' states that by October 1976 the RAF had committed forty-eight Vulcans, twelve UK-based Buccaneers, twenty-four RAF Germany-based Buccaneers and sixty Jaguars, all equipped with British nuclear weapons. Papers in TNA AIR 8/2785 say that each aircraft was allotted one sortie with a few weapons spare.
- 56 The scheduled in-service date was planned for June. TNA CAB 134/2241, 'Nuclear Requirements for Defence Committee, Draft British Programme of Underground Nuclear Tests 1965/66, Note by the UK Atomic Energy Authority', AWRE, 9 December 1964.

- 57 The original plan was for a force of four submarines and a 'total of about 200 warheads'. TNA FO 371/184413, 'Atlantic nuclear force 1965', WUN 1192/295/G, 'The Provision of British Warheads for the Atlantic Nuclear Force', draft paper by the Ministry of Defence for the DOPC Sub-committee on the ANF, July 1965; R J Andrew, MoD to E J W Barnes, Foreign Office, 13 July 1965.
- 58 The apparent intention appears to have been to deliver warheads to RNAD Coulport as follows: fifty-four in October 1967, fifty-four in April 1968, forty-eight in October 1968 and forty-eight in April 1969. See AVIA 65/1845, 'Polaris Assembly Programme Delivery to R.N.A.D. of Lifer Components', A H Porter to E G Richardson, DAS, 15 October 1964. The rationale for fifty-four warheads was because two missiles (three warheads x eighteen missiles for fifty-four) might fail final inspection prior to loading on the submarine at Coulport. AVIA 65/1845, S.Chard, DAWP & P to DGAW, 16 October 1964. The warhead was carried in the Mk II Mod 0 Re-Entry System – see TNA DEFE 69/472, 'Re-Entry System Progress Meeting', 18 June 1964.
- 59 This is based on sixteen missiles with three warheads deployed on each missile times four outloads for four SSBNs.
- 60 TNA AVIA 65/1845, 'Polaris Assembly Programme Delivery to R.N.A.D. of Lifer Components', A H Porter to E G Richardson, DAS, 15 October 1964. These were to be completed by September 1969. The production rate was planned at ninety-six ET317 warheads per year. TNA AVIA 65/1845, 'S Chard, DAWP & P to DGAW', 16 October 1964.
- 61 Unlike the surveillance rounds for Red Beard, Red Snow and the WE177 where fissile materiel was replaced by non-radioactive materiel, two live warheads were specifically ordered for this role for the ET317 warhead surveillance programme without affecting the navy's operational strength. One weapon would be dismantled sufficiently to allow some of the UK warhead non-nuclear components to be destructively tested. Weapons would be subsequently rebuilt and returned to the navy; see TNA DEFE 13/700, 'The UK Polaris Re-Entry System Surveillance Programme', William Cook, DCSA (P) to Secretary of State, 1 December 1966.
- 62 We also see that Chevaline warhead production requirements in the late 1970s meant that ET317 warheads had to be withdrawn in order to recover the fissile materiel. In 1976, sixty ET317 warheads were taken out of service, thereby reducing the navy to a three-boat force. See TNA 19/208, 'Minutes of KH.793 Project Management Executive', 4 July 1974.
- 63 Victor Macklen, DCA (PN), MoD, 'about 400 warheads', TNA DEFE 19/240, 'Record of a Meeting with Dr Frank Press, Presidential Adviser on Science and Technology', 16 February 1978.
- 64 The 462 figure is based on there being forty-three WE177A for RN use; fifty-nine WE177A for RAF use; fifty-three WE177Bs for the RAF; 125 WE177Cs for the RAF and 191 ET317 warheads for Polaris.